COLLECTOR SUBSTATION DESIGN CRITERIA

High River Energy Center

Collector Station

Florida, NY

Prepared for:

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Design Criteria Document

Substation Systems

Project: High River Collector Substation

Client: NextEra Energy

Project Location: Florida, NY

General Description

Summary

High River Collector Substation will be designed and built to collect roughly 90MW of PV solar power located in upstate New York and transmit to a nearby 115 kV interconnection point. The 100’ x 165’ substation yard will consist of two (2) incoming 34.5 kV collector line feeders, each with circuit breaker protection feeding onto the substation bus and through a 115-34.5 kV Power Transformer with associated 115 kV high voltage circuit breaker, disconnect switches, instrument transformers and revenue metering.

Standards and Reference Documents

Applicable federal, state, and local codes and standards shall also be observed. A summary of the industry codes and standards to be used are as follows:

Industry References

ANSI	American National Standards Institute
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NEC	National Electrical Code
RUS 1724E-300	U.S. Dept. of Agriculture Design Guide for Rural Substations
AISC	American Institute of Steel Construction
ASTM	American Society for Testing and Materials
ACI	American Concrete Institute
AWS	American Welding Society
IEEE	Institute of Electrical and Electronics Engineers

CSI	Construction Specifications Institute
NFPA	National Fire Protection Association
IES	Illuminating Engineering Society
ASCE	American Society of Civil Engineers
NPCC	Northeast Power Coordinating Council

Design Criteria & System Parameters

System Parameters – 115kV System	
Nominal Voltage	115kV Line to Line
Maximum Design Level Voltage	121kV
Basic Impulse Level	550kV
Design Continuous Amperage	1200 Amps
Fault Current Level (Equipment)	40kAIC (RMS Symmetrical)
Grounding	Grounded Wye
Post Project 3 Phase-Fault Current	20kA (3L-Gnd)
3 Phase Fault Current for Bus Design	30kA
Post Project 1 Line to Gnd. Fault Current	17.5kA
L-Gnd. Fault Current for Ground Grid Design	20kA
Min. Withstand Fault Capability:	
• Short Time	38kA
• RMS Asymmetrical (Momentary)	61kA
• Peak Asymmetrical	99kA
Post Project Line-Line Fault Current	30kA

System Parameters – 34.5kV System	
Nominal Voltage	34.5kV Line to Line
Maximum Design Level Voltage	35kV
Basic Impulse Level	200kV
Design Continuous Amperage	1200 Amps/2000 Amps
Fault Current Level (Equipment)	40kAIC (RMS Sym)
Grounding	Effectively Grounded
Post Project 3 Phase-Fault Current	20kA (3L-Gnd)
3 Phase Fault Current for Bus Design	25kA
Post Project 1 Line to Gnd. Fault Current	17.5kA
L-Gnd. Fault Current for Ground Grid Design	20kA
Min. Withstand Fault Capability:	
• Short Time	38kA
• RMS Asymmetrical (Momentary)	61kA
• Peak Asymmetrical	99kA
Post Project Line-Line Fault Current	30kA (client fault model)

Listed design values to be validated and updated during detail engineering based on System Impact Study (SIS) and corresponding Aspen fault model for the collector substation.

Electrical Clearances

Yard Clearances

The substation shall be designed to provide at a minimum, the yard clearances and spacing in Table 1-1. Equipment spacing shall be in accordance with the applicable codes.

Table 1-1 Yard Minimum Clearances			
Nominal Operating Voltage (Ph-Ph)[1,2], kV Nom	Basic Impulse Level (BIL)[1,2], kV Peak	Minimum Phase-to-Phase, Metal-to-Metal, Inches[1]	Phase-to-Ground, Metal-to-Metal,[1] Inches
115	550	53	47
34.5	200	18	15
[1] ANSI C37.32 [2] NESC, Section 12			

Outdoor Bus Clearances & Spacings

Standard Phase Spacings	115kV	10' – 0"
	34.5kV	3' – 0"

The substation bus shall be designed to maintain the clearances and spacing in Table 1-2. The values given below shall be treated as the minimum allowed.

Table 1-2 Minimum Bus Clearances (Outdoor)						
Nominal Operating Voltage (Ph-Ph), kV Nom	Basic Impulse Level (BIL), kV Peak	Vertical Clearance of Unguarded Parts,[2] Inches	Horizontal Clearance of Unguarded Parts,[2] Inches	Vertical Break Disconnecting Switches,[1] Inches	Side Break Disconnecting Switches,[1] Inches	All Horn Gap Switches (Vertical and Side Break),[1] Inches
115	550	139	73	84	108	120
34.5	200	114	48	36	48	60
[1] ANSI C37.32 [2] NESC, Section 12						

High & Medium Voltage Bus System & Hardware

Bus

Tubular bus fittings shall be 360-degree circumferential swage 2 piece compression type with NEMA configured equipment terminal pad configurations as manufactured by DMC or approved equal. All tubular bus spans exceeding 20’ shall include 795KCM AAC dampening cable for Aeolian vibration control. Bus supports shall be bolted aluminum two-piece ring type - capable of either slip of fixed support with anti-chatter springs. The 34.5kV tubular aluminum bus will be 2 or 4 inches I.P.S. and will transition to 1272KCM or 795KCM AAC to 115kV and 34.5kV yard equipment.

Conductors

115kV conductor leads for the yard equipment will be (1) 1272KCM AAC. Transformer conductor leads will be (1) 1272 AAC.

34.5kV conductor leads for the cable terminators and surge arresters will be (1) 1272KCM AAC. Transformer conductor leads will be (2) 1272KCM AAC.

Insulators

The load on the insulator (cantilever, tension, compression, torsion) shall not exceed the respective insulator strength published in ANSI C29.9, Tables 1 or 2. All insulators for the rigid bus system and disconnect switches shall be porcelain station post, standard creep, and shall be ANSI 70 gray in color. Standard strength, High strength or Extra-high strength insulators will be specified according to project criteria resulting from three phase symmetrical bus design fault current.

Apparatus Insulators (115kV):

- Nominal Voltage 115kV
- Type Station Post
- BIL 550kV
- Color ANSI-70
- Cantilever Strength 1700/2600 lbs standard/high strength
- NEMA TR No. 286/287

Apparatus Insulators (34.5kV):

- Nominal Voltage 34.5kV
- Type Station Post
- BIL 200kV
- Color ANSI-70
- Cantilever Strength 2000 lbs minimum 34.5kV (standard strength)
- NEMA TR No. TR-210

Major Equipment

(1) - 115/34.5/13.8 kV Power Transformer

•	Vendor	TBD
•	High Voltage	115kV Grounded-Wye
•	Low Voltage	34.5kV Grounded-Wye
•	Ter. Voltage	13.8kV Delta (Buried)
•	MVA	69/92/115

34.5 kV Switch

•	Vendor	TBD
•	Type	Vertical Break
•	Voltage	38kV
•	BIL	200kV
•	Cont. Current	1200A
•	kA Mom.	61kA

115 kV Operated Line Switch

•	Vendor	TBD
•	Type	Vertical Break
•	Voltage	115kV
•	BIL	550kV
•	Cont. Current	1200A
•	kA Mom.	61kA
•	Control Volt.	125VDC

115 kV Transformer Switch

•	Vendor	TBD
•	Type	Center Break
•	Voltage	115kV
•	BIL	550kV
•	Cont. Current	1200A
•	kA Mom.	61kA

115 kV Ground Switch

•	Vendor	TBD
•	Type	Vertical Break
•	Voltage	115kV
•	BIL	550kV
•	kA Mom.	61kA

AC Station Service

Design Criteria

The AC station service system shall be sized to accommodate all new and known future substation AC power requirements. AC Station service will be established from two independent sources.

The Primary station service will originate from the 34.5kV bus and feed a single phase 25kVA transformer. A 240/120V grounded-wye, 1 phase, 3 wire secondary will be derived and used as the Primary station service.

The Alternate station service will originate from a nearby distribution line or emergency generator and will be selected during the detailed design process.

An automatic transfer switch (ATS) will be installed and fed from the two independent station service sources.

Substation Lighting

Design Criteria

All interior building and exterior yard lighting will be designed per NextEra Energy or applicable industry standard. Outdoor Yard lighting designed to a 3.0 foot-candle average, and will be building wall, and pole structure mounted. Light fixture maintenance can be accomplished with equipment / bus in service by qualified personnel.

Materials

- Building Entry Light, Wallpack, 70W, HPS, with Full Visor
    - Lithonia TWA-70S
- Floodlight, 250W, HPS
    - Lithonia TFLU-250S

Direct Stroke Protection

Design Criteria

A two (2) 60ft. lightning mast with shield wire will be utilized for the direct stroke protection. The analysis of the lightning protection for the substation yard will employ IEEE-998 “Rolling Sphere method” for the 115kV voltage level and “Fixed Angle method” for the voltages below 115kV.

Grounding

Design Criteria

The fault current that will be used for grounding system design will be based on 20 kA. IEEE-80 Standard current split factor will be used to determine the return ground current.

Subgrade Grounding

A 4/0 (19 strand) copperweld conductor will be installed 18" below finish yard grade. The 4/0 conductor will be arranged throughout the yard in an overlapping rectangular grid pattern, extending 3 feet beyond the fence line (including gate swing radius), with 20 foot by 20 foot spacing as determined by design software. The grid spacing will be closer in the proximity of electrical equipment and will be connected at all conductor intersections. Two (2) steel copper clad ground rods ¾" x 10' with threaded couplings will be installed as dictated by design software and client standards throughout the yard area connected to the 4/0 grid, to enhance the grid system's effectiveness, by penetrating into stable & lower resistivity unfrozen soil layers. The sub-grade ground grid connectors will be the "Hyground irreversible compression system" type - as manufactured by Burndy. All group operated airswitch mechanisms will have personnel protection mats below grade (installed with 4" of crushed stone cover) at each operating mechanism location. This protection mat will be connected to the operating handle, and to the ground grid to maximize personnel protection from touch potentials. Connected pigtails (4/0) extending from the subgrade grid to the base of equipment structures, and stands will bond all above grade facilities. The below grade grounding conductor will loop around yard structures. The substation yard finish grade will consist of a 4-inch layer of coarse crushed rock (3,000 OHM-meter), which is considered for safe yard step and touch potentials.

Structure & Equipment Grounding

Ground grid pigtails will connect to the base of structure legs using bronze bolted or copper compression clamps as required at each leg for single and double leg structures, or at diagonally opposite legs for four leg structures and stands. Bronze mechanical connectors will also support jacketed 4/0 copper conductor to be run along structures and stands for grounding of equipment casings, surge arresters, ground switches, and overhead shield wires.

Where aluminum structures are used, bolted connections will be used, and connections will be plated to accept copper conductors. Copper conductors shall be covered in solid dielectric insulation to avoid dissimilar metal corrosion from the contact of aluminum and copper.

All above grade equipment will be properly bonded to the station ground grid using a continuous conductor path.

Fence Grounding

The substation perimeter fence posts will be bonded using 4/0 copperweld pigtails from the station ground grid at regular intervals, and where each overhead transmission phase conductor (if applicable) crosses the fence line with bolted bronze pipe-type mechanical connectors. Fence corner and gate posts shall be bonded directly to a ground rod. Gate frames and top rails will be bonded with 1/0 stranded copper, with the gate frame using a high strand 600V welding cable for maximum flexibility. Grounding of the chain-link fence, barbs, and bottom tension wire will be completed with a #2 stranded bare copper conductor and tinned bronze split bolt mechanical connectors.